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ABSTRACT

A study examined the training required for a wide range of occupations in which workers use computers or computer-controlled equipment. It was determined that although computer use is widespread and growing rapidly, relatively few workers (about 5 percent) need extensive education or training in computer-related skills. Because most workers involved with computers use them as tools in their jobs and work primarily with already-prepared computer software, they can learn computer-related skills in brief on-the-job training ranging anywhere from a few hours to a few weeks. Thus, it would appear that young workers need not fear being frozen out of the job market because they have not learned about computers. Because the computer skills required are, in most occupations, only a small part of the total work skills, the trend toward ever-increasing use of computers in the workplace will not impose correspondingly large demands on the education and training system. Schools already appear to be teaching word processing and electronic and computer technology effectively. Based on the finding that not more than two percent of all workers need to be able to program computers, it would seem that the inclusion of training in computer programming in general computer literacy studies could only be justified on general education grounds. Two areas where the schools do have an important role to play, however, are in offering vocational guidance and counseling in the area of computer-related occupations and retraining displaced workers in a broad spectrum of skill areas that includes but is not limited to computer-related skills. (MN)

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TRAINING FOR WORK IN THE COMPUTER AGE: POLICY IMPLICATIONS

BY

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TRAINING FOR WORK IN THE COMPUTER AGE: POLICY IMPLICATIONS

Computers have rapidly achieved widespread use, permeating many industries and affecting many kinds of workers. The growing use of computers has created concern about job placement, skill obsolescence, the adequacy of education and training, and additional barriers for minorities to overcome in gaining work skills. Policymakers ask how they can best equip Americans, young and old, to work and live in an age of computers. Questions arise about the roles of employers, schools, and government in helping people to get the training needed.

To provide answers to some of these questions, the National Institute for Work and Learning (NIWL) undertook a study for the National Commission for Employment Policy to find out what training is required for work with computers or computer-controlled equipment.

The study identified a wide range of occupations in which workers use computers. Interviews were conducted with employers, workers, trade and professional associations, unions, computer manufacturers, and schools to learn what workers do with computers and how they learn to do it.

The main conclusion of the study was that, although computer use is widespread and growing rapidly, relatively few workers need extensive education or training in computer-related skills; most learn their skills in brief on-the-job training. Young workers need not fear being frozen out of the job market because they have not learned about computers.

Study Findings

The rapid growth of computer use and its penetration into all sectors of the economy is illustrated by these key figures:

- Seven and a half million commercial or professional type computers (as distinct from home models) were in use at the end of 1984. In 1984 alone, over two million were sold.

- About 140 occupations were identified in which some workers use computers. They comprise about 30 percent of the work force, but less than half the workers in these occupations use computers at present - about one worker in eight in the total workforce.

The significant fact is that the number of workers using computers is growing rapidly. The sale of over two million computers in 1984 (some of which replaced older equipment) means that more than two million additional workers had to learn to use computers in a single year - a number more than half as large as the combined annual high school and college graduating classes.

NIWL's study found that extensive computer-related training is needed by relatively few workers. The one out of eight workers using computers fall into three major groups with respect to training requirements:

I. About five percent of computer users (less than one percent of all workers) require long periods of training. They include the engineers and scientists who design computers, teachers of computer science, computer programmers, systems analysts, and repairers. These occupations are growing rapidly, but by 1995 they will still be no more than about one percent of the workforce. The fact that this critical group of workers is relatively small does not diminish the immense importance of the quality of their training to the future of computer technology and American competitiveness.

The rest of the workers involved with computers use them as tools in their jobs, mostly with already-prepared computer programs.

II. Some engineers, scientists, technicians, accountants, and other professional and technical workers cannot always get software that will do their work and have to be able to write their own programs. These workers amount to roughly five to ten percent of computer users and about one percent of all workers. They can learn programming by taking a single college course, or other brief training, or by reading a manual. Whatever method they follow, the real learning takes place on the job as they gain experience. Few become as expert as professional programmers.

III. All the rest of computer users operate computers with available software for such purposes as data or word processing, information storage/retrieval, or industrial process control. They can learn the necessary skills by brief training, from a few hours to a few weeks, followed by a period of learning in the course of work.

For nearly all workers in groups II and III, computer skills are a small addition to the total job skills in each occupation. For most employed workers the training is paid for by employers and provided by the companies' own training or supervisory staffs, vendors of computing equipment, professional associations, unions, or schools. Some learn their entire craft skills in longer training programs in which a small part of the time is spent learning the computer aspects of the job. For workers not yet employed, schools can effectively teach some computer skills if students have ample opportunities for practice.

As computer use spreads, it is likely that the largest increase in the number of workers requiring computer skills will be in the third category requiring minimal, quickly-learned skills. In an intensely competitive market, software producers vie with each other to provide "user-friendly" programs for many applications, reducing the need for users to write their own programs.

The preponderance of employer-provided training for the third group of occupations reflects both the need to train currently-employed workers quickly in response to the rapid introduction of computers and the fact that fast-changing technology and threatened obsolescence of existing equipment favor on-the-job training. As emphasis shifts to training of new workers, however, the schools are likely to have a somewhat greater role, especially in training in word processing, electronics, and programming and in incorporating computer aspects into the general training programs for various occupations.

Two points that came up frequently in the study interviews bear on the shaping of schools' computer training curricula: the computer skills in any occupation are only a small part of the total work skills; and ample opportunity for practice is essential in learning computer operating and programming skills.

How can we be sure that the information on which this study is based, reflecting the current situation, is appropriate for planning education and training policies designed to meet the future requirements of jobs in a rapidly changing technological environment? First, with one worker in eight already using computers, major patterns of computer use, skill requirements, and training methods have developed and become well-established. Second, to reflect the future as much as possible, we included occupations in which any workers, however few, now use computers, on the assumption that once their use has been introduced in an occupation, it is likely to spread; and, in the interviews on each occupation, we tried to be sensitive to changes now under way and to describe the most advanced applications of computers rather than the most typical. While new applications not now foreseen will be developed, experience has shown that after any innovation is actually introduced, it takes time for use to become widespread. We can be reasonably confident of the validity of the findings as a guide to education and training policy for several years. To pick up emerging changes, a study like this should be repeated at least every five years.

The finding, supported overwhelmingly by the many interviews we conducted, that the widespread use of computers in work will not impose correspondingly large demands on the education and training system, as far as can be seen presently, may be surprising to many observers of the computer revolution. It may also seem paradoxical that such widespread use of a technology which many people associate with abstruse mathematics and electronics can be attained with relatively little special education and training. Yet this conclusion emerges clearly from the many interviews conducted. To understand this, one needs to recall that such innovations as automobiles, televisions, plastics, telephones, and electricity have become nearly universal while requiring relatively few

highly-trained workers in their manufacture, installation, and repair. The computer is becoming prevalent mainly because it has been designed, and constantly and ingeniously improved, to make it easy to use.

Policy Implications of Findings

The study findings on the training required by people who work with computers are helpful in considering a number of policy issues in education and training.

A. Role of Schools in Computer Education

We have found that, except for the comparatively small numbers of workers who require extensive computer-related training and the professional and technical workers who learn programming and other computer use in the course of their college or university training, most people who work with computers have been trained on the job by their employers or sent by them for training to equipment vendors, professional associations, or schools.

This may be an accommodation to the fact that with the rapid introduction of computers, incumbents of jobs have had to be trained quickly. If so, the question arises: is there a greater role for schools in the future in training workers who use computers but are not required to program them; at what level of the educational system; and for which computer-related skills.

We noted two kinds of computer-related skills that schools are already teaching effectively: word processing (which may ultimately be taught as part of typing courses) and electronic and computer technology. Secondary and postsecondary schools may assume a greater role in these kinds of training.

For occupations which do not do programming or word processing and are not involved in maintenance of computer and electronic equipment (that is, the great majority of workers who operate computers, using a keyboard, as a tool in their work), the computer skills can be learned quickly. Since a variety of equipment and software are in use, there are advantages to trainees learning on the equipment they will be using in their jobs, performing the specific tasks they will be doing. This favors on-the-job training, the principal mode of learning now followed. As long as computer use continues to grow rapidly and new models continue to come out, on-the-job training will continue to be the major way in which the skills are learned. Experience and familiarity with computers undoubtedly help in this learning process--whether the experience is in other jobs, or in computer-assisted instruction in school subjects, or hands-on experience in a "computer literacy" course. But even for people without experience the learning is so rapid that experiences of the kind mentioned do not speed up the learning significantly. Employers who have instituted programs of on-the-job training will probably assume that all new workers have to go through the program, whether or not they have some of these kinds of computer experience. Most training programs are designed to impart all the skills required in the job, of which computer skills are a small part, and there is little chance that trainers or supervisors would excuse from minor parts of the program those workers who claim to have had relevant computer experience.

There are other occupations in which school-based training programs in a computer skill may provide a competitive advantage. These include some of the technician and repair occupations for which technical school training in electronics provides a good base for learning.

Another situation in which schools can give computer-related training effectively is where it is part of a general program for training in all aspects of the work of an occupation--for example, calculating and other office applications should be taught in courses in bookkeeping and accounting methods. Applications in the building trades, such as construction management and cost estimating, should be taught as part of the vocational curriculum in this field. The ways in which computers are used and how they relate to other aspects of the craft or profession are a substantial body of knowledge, and an important part of training for the occupation, while the keyboard operating skill itself is quickly learned and hardly worth the trouble to take training for it in school. Schools emphasizing the use of the computer as an occupational tool make a significant contribution to training for work.

There still remains the question of general education about computers for all youth, which is sometimes discussed under the rubric of "computer literacy." The NIWL study, which was focused on the training required for work with computers, did not try to evaluate what should be taught about computers as a contribution to general education. Nevertheless, some of the study findings may be helpful to those planning computer literacy education.

On the basis of the finding that no more than two percent of all workers need to be able to program computers, a question might be raised as to whether computer programming should be part of a general computer literacy studies program for the population as a whole. Its inclusion could only be justified on general educational grounds - for example, if it has value as a discipline or conveys an understanding of the logical foundations of computer technology. There are some precedents for this:

despite the small percentage of workers who use them in their work, geometry and foreign languages, for example, are in the general curriculum, justified mainly on their educational value rather than as preparation for work.

One other comment may be relevant to the issue of computer literacy education. There is a substantial effort in the elementary and secondary schools to introduce computer-assisted methods for the teaching of school subjects. In schools where this becomes prevalent, children will get some experience in operating computers with keyboards and some understanding of what computers are like and what they do. These, of course, are some of the goals of most plans for computer literacy education. In this respect, success in developing computer-assisted teaching reduces the need for computer literacy education.

As schools consider what approach to broad computer literacy education they will follow, they must, of course, consider the trade-off between the benefits and the costs, which include taking the limited time of students and the limited resources of schools. What is involved are trade-offs in educational emphases. In trying to give students the best foundation for dealing with this particular technology, schools may want to consider how students can best be prepared to deal with technological change in general. Important components of such learning may include literacy, facility in learning new subjects, study skills, and a broad understanding of the scientific and humanistic base of various work technologies--physics, mechanics, chemistry, biology, mathematics, social sciences, and language. It is in relation to the total education of youth to deal with technological change that the need for and content of computer literacy instruction can best be evaluated.

The schools have an additional role in relation to education about the computer: their responsibility to provide vocational guidance and counseling. Accurate and realistic information should be provided to students about the computer training requirements in the various occupations, to counteract some of the misinformation that is widely current. (For detailed occupation-by occupation information, see Getting a Job in the Computer Age by Harold Goldstein and Bryna Shore Fraser, Peterson's Guides, 1986.)

B. Retraining Displaced Workers

One of the concerns in policy discussions revolving around the invasion of the workplace by computers has been whether workers displaced by computer technology--or indeed by any other factor, such as foreign competition that has hit the automobile, steel, textile, apparel, and shoe industries--can and should be retrained in "high tech" occupations such as work with computers--a measure designed to reduce structural unemployment.

Questions have been raised as to the feasibility of large retraining programs of this kind: do the new jobs require higher educational levels than the displaced workers possess, and if so can their educational deficiencies be made up? Are the displaced workers in the same geographical areas as the "high tech" industries, or are they or the industries willing to move? Are there enough jobs to accommodate them--or at least those who are able to benefit from the training and move to the jobs? Despite the popularity of the buzz word, "high tech" industries and occupations involve a relatively small number of jobs.

A relevant finding of the NIWL study is that for most computer-related jobs (all, in fact, but the few created by the computer itself, such as programmers, systems analysts, computer repairers, computer operators, and

data entry keyers), the computer skills required are but a small part of the total skill content of the jobs. Retraining programs, therefore, cannot focus on computer skills alone--unless they are to train for the one percent of all jobs included in the computer-created occupations themselves--but rather have to be designed to give trainees the full range of skills needed in occupations in which they are to seek reemployment. Displaced workers who already have all the skills required for a job except the computer skills should have no trouble in getting any jobs that are open; experience has shown that employers are willing to hire workers who otherwise have the job skills and equip them with needed computer skills by putting them through brief training programs. It would not be necessary for government agencies or communities to set up programs to accomplish this.

C. Training Programs Offered by the Computer Industry

The large training enterprises operated by computer vendors, mainly manufacturers of computer equipment but also including software companies, offer courses and training materials (textbooks and software for computer-assisted training) for fees, but manufacturers also commonly provide some free training to the employees of firms that buy equipment. Vendors have to face a number of policy issues with respect to their training programs, and their decisions have a bearing on the training policies of both the companies who are customers and the schools.

Giving free training to customers is not only a sales inducement but also helps to assure that the equipment will be efficiently used and therefore promote customer satisfaction and lead to repeat business. There are a number of questions the vendor has to address, however, including: how many employees of a customer should be given the free training; how

long should it be given for each purchaser--e.g., should it be given to employees hired to replace those who have been trained and then left their jobs; does free training encourage customers to send less able employees than if they had to pay for the training; does giving free training (the cost of which has to be included in the price of the equipment sold) make customers who require less training bear part of the costs for those who require more; does it makes the price of equipment less competitive; is there danger that the equipment manufacturer's policy officials will see the training program as a burden to be skimped on when the business situation deteriorates, with an inevitable effect on customer satisfaction.

Companies trying to be restrictive in offering free training have to be concerned that competitors may be more generous. Similar considerations affect the decisions on fees to charge for training; there is a wide range among vendors in tuition fee schedules per day of training. Still another issue is the question of how long to offer courses relevant to older equipment when substantially different new models have been introduced.

Many of these problems disappear if the vendor follows a policy of charging fees for all training and setting the fee schedule so that the training enterprise is self-supporting. But considerations of customer relations do enter and require some subsidization of the sales department by the training department.

The pricing policies for vendor-provided training affect both the in-house training policies of customers and the programs of schools and colleges. If vendor-provided training becomes expensive, the other providers will be under pressure to expand their services.

D. The Choices for an Individual

The individual who is not employed, whether in school or looking for work, has to consider whether taking some training in computer skills would be useful in getting a job and building a career, and what kind of training would be most helpful.

The descriptions of computer use and training in many occupations in Getting a Job in the Computer Age (the companion volume to this paper) will give some guidance on this question. They indicate the kinds of computer training needed, and whether employers expect to give the training themselves or are looking for job applicants who already have some relevant training or experiences.

Two points frequently emphasized in the many interviews were: (1) for most occupations the computer skill is a small part of the total skill requirements in the occupation and (2) computer operating or programming skills may be introduced in a classroom but are only developed by experience in doing the work.

The first point strongly suggests that the person preparing for work in an occupation should give the greatest attention to developing all the work skills required in that occupation and should not allocate too much time or invest too much money in learning the computer skills alone. For example, for secretarial work it is important to develop the variety of skills, including language skills, required in the job; word processing and other computer skills are learned easily compared to the others. Similarly, an accountant or an airplane engine mechanic should devote most time to the non-computer skills of the occupation.

The second point implies that if the individual takes a computer training course it would be best to select one that provides a great deal

of time for practice. This is true whether it is a course in programming (required in a limited number of occupations) or in operating the computer, as in word processing. If instead of taking a formal course the individual chooses to study programming, word processing, computation, storage and retrieval or other computer skills from a manual, it is essential to have access to a computer for long periods of time to practice.

It goes without saying that the kind of training one takes should be geared to the kind of work one expects to do. In programming, for example, it is important to learn a language appropriate to the applications one will be working with. In word processing it would save time in re-learning if the individual learns to use a program and equipment similar to what is used in the workplaces where he or she will be seeking a job.

E. Looking Ahead

The finding that widespread use of computers in work will not impose correspondingly large demands on the education and training system may be surprising to some, but it should be reassuring particularly in view of the unusual nature of this technological innovation.

That this is an extraordinary innovation there can be no doubt. Most new technologies affect not much more than a single industry or occupation, even though they may have profound effects on our lives. Examples that come to mind are the sewing machine, radio and television, and air conditioning. Some few others have had a broader effect on other industries, such as the automobile, which affected other forms of transportation and such industries as rubber, glass, highway construction, and tourism, as well as the distribution of population around cities. But few innovations have had as pervasive an effect as the computer on the way work is done in all industries and by people in many occupations. In this

respect the computer's effects may be compared only to such immense innovations as the use of power machinery, which initiated the industrial revolution.

In view of this, it is natural that educators and employers should have anticipated major demands on education and training institutions to equip the work force with new skills. To make the system responsive, secondary and postsecondary schools, public and private, have introduced new courses, developed and tried to define the concept of computer literacy, and adopted requirements for computer skills in the training and certification of teachers in same states.

It may come as a surprise to many, therefore, that when the skill requirements for work with computers are ascertained in specific and concrete terms, as was done in the NIWL study, it should be found that by far the majority of workers involved can learn the skills quickly with brief formal or informal training by employers, and that no large burden will be imposed on the educational system to prepare students for work in the computer age. The burden on the educational system will be centered on a few sectors: departments of electrical and electronic engineering (and related basic sciences) and departments of computer science in colleges; and the teaching of such subjects as electronics, typing skills, and business and accounting practices in vocational and technical schools. Some additional workload will be taken on by the schools if they develop computer literacy as a component of general education. The revolutionary new technology will not, however, drastically change educational requirements for work, as far as can now be seen.

We should remember, however, that while the computer revolution has gone beyond its infancy, it is still in an early phase, and as the technology advances (artificial intelligence is still under development, for example), and as computer use spreads to other applications, new and different educational implications and policy issues may emerge. This could be well into the future. When automobiles first frightened horses on city streets, who could have predicted - with enough assurance to base private action and public policy - that 80 years later, millions of new jobs would have been created, suburbs would have grown, central cities decayed, and the great railroads replaced by superhighways? Similarly, vast unforeseen effects may follow from the computer, and to be forewarned we must closely watch the progress of this latest innovation.